Software for Automated Generation of Reduced Thermal Models for Spacecraft Thermal Control, Phase I

Completed Technology Project (2010 - 2010)

Project Introduction

Thermal analysis is increasingly used in thermal engineering of spacecrafts in every stage, including design, test, and ground-operation simulation. Current high-fidelity modeling and simulation tools are computationally prohibitive and not fully compatible to integrated, multi-physics (e.g., thermal-structural-optical) analysis of spacecrafts, particularly in a single model topology currently being pursued at NASA. NASA engineers are challenged with developing innovative reduction algorithms and models that enable rapid analysis while retaining adequate accuracy. To address this need, we propose to develop and demonstrate innovative Model Order Reduction (MOR) software to automatically generate nonlinear reduced thermal models for spacecraft analysis. The underlying principle is to project the original large models onto a characteristic, low-dimensional subspace (SVD or Krylov subspace), yielding reduced models with markedly low computational orders. In Phase I, a MOR engine encapsulating carefully selected algorithms, a reduced model solver, and a verification module, along with facile data export interfaces will be developed in an integrated software environment. Proof-of-concept will be established by broad case studies, in which reduced models will be analyzed and compared against large model analysis using CFDRC-developed multi-physics simulation tool CFD-ACE+ in terms of accuracy, speed, and resource use. Phase II will focus on enhancing the MOR engine, optimizing the software structure, and expanding interfaces to other NASA-relevant tools.

Primary U.S. Work Locations and Key Partners
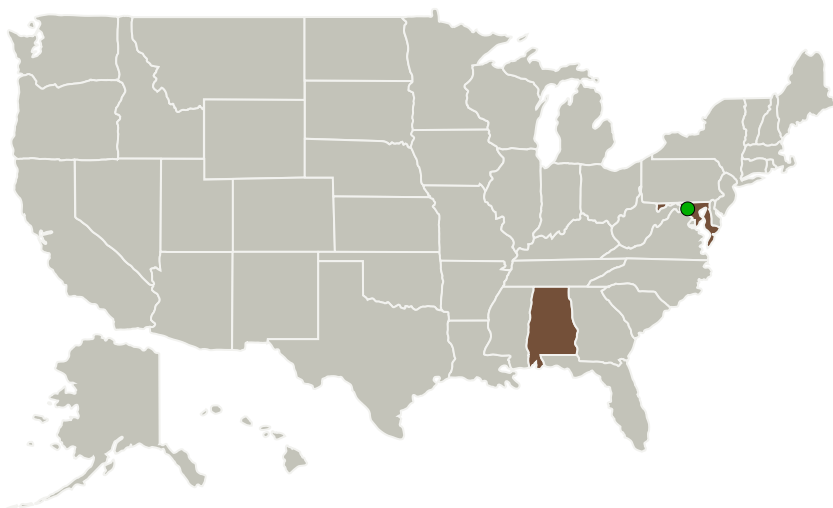
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Organizations Performing Work	Role	Type	Location
CFD Research Corporation	Lead Organization	Industry	Huntsville, Alabama
● Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
Alabama	Maryland

Project Transitions

▶ **January 2010:** Project Start

✔ **July 2010:** Closed out

Closeout Documentation:
- Final Summary Chart*(https://techport.nasa.gov/file/140023)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CFD Research Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Yi Wang

Co-Investigator:

Yi Wang

Technology Maturity (TRL)

Start: **1**
Current: **3**
Estimated End: **3**

1	2	3	4	5	6	7	8	9
Applied Research			Development			Demo & Test		

Technology Areas

Primary:

- TX14 Thermal Management Systems
    └ TX14.2 Thermal Control Components and Systems
        └ TX14.2.5 Thermal Control Analysis

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System